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ABSTRACT

Beginning with a preconceived bias that "real" (i.e. nonartifactual) age differences in transfer and retroaction do exist, the author feels that the available literature permits no clear conclusions relating the process of aging and transfer mechanisms, or aging and retroaction. Research to date is viewed as assuming that "interference" manifests its effects over the age continuum and implies that an increased susceptibility to interference in the aged is unmodifiable. A more optimum research strategy, it is held, would concentrate on experimental manipulations which lead to the modification of age-performance functions. The bulk of the paper focuses on the research and implications which follow the adoption of this "modification" strategy. Three major classes of variables, of major interest in the study of learning and memory in the aged, provide the context: (1) degree of learning; (2) mediated vs. non-mediated learning; and (3) response time. The emphasis is on the provisions of alternate, empirical methods to provide for sources of confounding which mitigate against unbaised age-comparisons of the processes of retention and memory. (TI)

General and Specific Interference Factors in Retention[1]

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My interest in this symposium stems directly from a concern with learning and cognitive processes in general and with the developmental changes in transfer and retroaction which occur over the life-span in specific. I share with many of you the preconceived bias that "real"; i.e., non-artifactual, age-differences in transfer and retroaction do exist. And, perhaps you share with me my general dissatisfaction with the state of the literature in the area. In short, I suggest that the available literature permits no clear conclusions to be drawn relating the processes of aging and transfer mechanisms, or aging and retroaction. Furthermore, I suggest that, with few exceptions, the research conducted within this context has been predicated on the assumption that its primary purpose was to describe the relation between age and transfer or retroaction. As is apparent, such an approach is inherently descriptive in nature and mitigates against providing an explanation of the nature of ontogenetic change. The basic model for developmental research should rather be based on the systematic, experimental manipulation of variables hypothesized to be associated with development or aging. In short, within the context of a simple Age X Treatment analysis of variance design, the primary emphasis should be directed to the simple effects of the experimental variable at each level of age rather than the opposite.

My point here becomes more clear if I phrase the example in another way. It is perhaps fair to state that most researchers interested in

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ontogenetic change at least implicitly entertain hypotheses concerning the nature of a specified age-performance function and have explanations for this function if indeed their suspicions are confirmed. With regard to retroaction, for example, a hypothesis shared by many is that retroaction increases with age after middle adulthood. The explanation most often provided is that the aged are more "interference prone" than their younger adult counterparts (e.g., Jerome, 1959). Other variations on this general theme will be discussed later. The important points here are that "interference proneness" as an explanation does not specify the manner in which "interference" manifests its effects over the age continuum, and unless qualified, implies that the increased susceptibility to interference in the aged is unmodifiable; i.e., unidirectional. Thus, entertaining such an hypothesis, the researcher is directed to "discovering" the general form of the age-retroaction function.

I maintain that a more optimum research strategy when concerned with developmental problems is to concentrate on experimental manipulations which lead to the modification of age-performance functions (Baltes & Goulet, 1970). Again, in the context of the simple effects in an analysis of variance, the focus should be oriented to determining the variables whose effects increase or decrease the magnitude of retroaction for the age samples under study. As mentioned previously, such an approach directs the focus of investigation to the experimental manipulations, and which, nevertheless, also permits the generation of a class of age-performance functions. It is clear that these suggestions require a change of focus rather than a change of research design. However, the

emphasis on the modification of age functions has heuristic value since it provides additional perspectives not directly apparent when the focus is on the simple effects of age.

The remaining parts of the paper focus on the research and theoretical implications which follow from the adoption of such a "modification" strategy. For expository purposes, these implications are discussed within the context of three major classes of variables: degree of learning, mediated versus non-mediated learning, and response-time. The effects of these variables have been and are of major interest in the study of learning and retention processes of the aged.

Degree of learning. Most published work relating to aging and retention devotes at least some attention to the variable of degree of learning. For the most part, the concern, at least for the studies not directly involved with the manipulation of this variable, has been primarily methodological in nature. Here, the major problem has been to equate the amount or degree of learning among the samples for which measures of retention are being collected and compared.

The attention to the problem of equating for degree of learning is of singular importance since any unequivocal demonstration of an age-related retention deficit requires either that the to-be-retained material is equally available, i.e., learned to an equal degree in acquisition for the samples being tested, or that we have full knowledge regarding the age-degree of learning-retention interaction matrix. The latter possibility obviously puts the "cart before the horse."

The degree-of-learning problem is especially acute in developmental research since age and the criterion of mastery on learning problems is correlated throughout the entire life span, albeit negative from early childhood through maturity and positive from middle adulthood thereafter (Arenberg, 1967; Bromley, 1958; Canestrari, 1963, 1968; Inglis, Ankus, & Sykes, 1968; Jensen & Rohwer, 1965).

The attempted solutions to this problem have taken a number of forms. The method used most often in research on aging has involved taking all subjects to the same criterion of mastery (e.g., one perfect repetition of a list of paired-associates) on the to-be-retained material. Such methods inherently suffer from the fact that the "true" degree of learning of the individual items in the list is unmeasurable if indeed learning continues beyond the point where performance on these items has reached an asymptote (Underwood, 1964).

An alternate method involves presenting the material for a constant number of trials for all samples. With this method, differences in retention may reflect either the influences of forgetting or simply differences in the original level of learning over the practice trials. In using this method Underwood (1964) has suggested a means of obtaining an estimate of the degree of learning attained by slower- and faster-learning samples and using these estimates as a base against which to measure retention in these samples. The use of such a method in developmental research, however, assumes the absence of an interaction between degree of learning and age in retention, an assumption which is not tenable at the present time (Goulet, in press).

Similarly, Underwood (1964) has provided methods which have use in age-retention comparisons when Ss are taken to the same criterion of learning. The major difference in the methods suggested by Underwood (1964) and those commonly used in developmental studies of retention is that Underwood suggests equating samples on the degree of projected learning, rather than taking samples to the same criterion of mastery.

The use of the projection methods proposed by Underwood has been strongly suggested by a number of authors (e.g., Goulet, 1968c; Kausler, 1970; Kay, 1968). However, it is obvious that their use in a developmental context directs the focus to the cross-age or descriptive components inherent in the data.

I suggest that the more appropriate focus is on the experimental variables which affect the magnitude of retention. Furthermore, I suggest along with others (e.g., Hulicka, 1967) that variables such as degree of learning are primarily of theoretical rather than methodological interest. Last, I suggest that primary attention must be given to identifying the age-correlated mechanisms or process-components through which degree of learning exerts its effects on performance across the life-span.

In the context of retention, for example, the recall of a single list of paired-associates may be assumed to be a function of at least three variables:

1) The amount of practice provided on the list or lists which are to be recalled.

2) The extra-experimental familiarity with the materials in the list.

and, 3) The general familiarity with the requirements of the learning (i.e., paired-associates) task.

The first variable, degree of experimental practice, actually confounds the two components represented in (2) and (3) above; i.e., during practice the subject is acquiring additional familiarity with the materials, but not as apparent, he is also acquiring proficiency in learning paired-associates. In the context of verbal learning theory and methodology (e.g., Kausler, 1966; Underwood, 1966), these two components are identified as those of specific transfer and non-specific transfer (e.g. learning to learn), respectively. Either of these components may directly or indirectly affect retention of the list. And, in a developmental context, to the degree that specific transfer [reflected in (1) or (2) above] or non-specific transfer [reflected in (1) or (3) above] vary systematically with age, retention will also vary.

As is apparent, even the use of the projection methods proposed by Underwood (1964) in a developmental context does not assure equal degrees of learning across age for each of the components. Thus, the "equating" may reflect nothing other than the pooled but differential effects of these two components at each age for which retention is being measured.

The above analysis of the components involved in the degree of learning-retention issue suggest that the research emphasis should be directed to the determination of the relation between each component and retention at each age level of interest. Fortunately, these components can be manipulated independently of one another (Goulet, 1968b, 1968c, in press; Postman, 1969), non-specific transfer components being a function of the amount of prior practice and the higher-order habits acquired as a result of learning similar tasks (e.g., other paired-associate lists) and specific transfer components being a function of the acquired familiarity with the to-be-retained materials.

The adoption of this research strategy serves two purposes. First, it provides the opportunity to determine the influence of each of these components on retention. To the degree that they exert different effects across age, suggestive information regarding the developmental antecedents of learning and retention processes will be obtained. Second, and in the methodological sense implied by Underwood (1964), exact and empirical methods of equating for degree of learning can be specified. As an example here, rate of learning can be equated by providing learning-to-learn practice in the amount necessary to assure that the learning task is acquired in the same amount of time (i.e., at the same rate) and to the same degree by each of the samples tested.

Space limitations prevent additional discussion of the implications of the above analysis. Assuredly, the assumptions made require additional clarification and the validity of the proposed methods must be checked. Nevertheless, the approaches provide for the experimental analysis of aging and retention processes. Furthermore, they provide the possibility of isolating the mechanisms of retention free from confounding from differential degrees of learning. The effects of such confounding have already been highlighted by Hulicka (1967) in the context of retroaction and by Hulicka and Weiss (1965) in studying simple retention.

Mediated versus non-mediated learning. A second class of variables which has major import for the study of age-sensitive retention processes relates to distinctions of a qualitative nature, including questions as to what is learned and how learning occurs, as well as bearing directly on developmental hypotheses associated with both ends of the age spectrum.

For example, Kausler (1970) has recognized the broad distinction between rote versus mediated associative learning, the latter having reference to acquisition processes mediated by verbal or visual mnemonic devices employed by the subject.

There is increasing evidence that both acquisition and retention are markedly facilitated in young adult subjects when mnemonic devices are used (e.g., Adams, 1967; Adams & Montague, 1967; Bugelski, 1968). Such findings can also be generalized to children (e.g., Jensen & Rohwer, 1965; Milgram, 1967; Reese, 1965). There is also increasing evidence that the spontaneous, unprompted use of mnemonic devices in acquisition increases with age in children (e.g., Flavell, Beach, & Chinsky, 1966; Flavell, 1970) and then declines after middle adulthood (e.g., Canestrari, 1968; Grimm, 1970; Hulicka & Grossman, 1967; Hulicka, Sterns, & Grossman, 1967). Such findings, in themselves, provide a first-approximation to explaining any retention deficit in either the young or the elderly if the assumption is made that mediated habits are "protected" from interfering activities, are more resistant to interference from competing habits, or that mediated habits are simply better learned than those acquired rotely (Kausler, 1970).

Furthermore, the provision of instructions to mediate or to use mnemonic aids in learning to Ss before (and during) acquisition for samples varying in age is perhaps appropriate in most studies involving the age variable. Such a procedure should assist in equating both the degree and type of learning for the samples involved in developmental studies (Hulicka & Grossman, 1967; Jensen & Rohwer, 1965). Without such instructions, retention deficits demonstrated in the young or the elderly may either be

artifactual due to the different proportions of subjects in each age sample who spontaneously employ mnemonic aids in learning or retention, or may reflect actual age changes in retention.

Again, it is imperative to emphasize the experimental manipulation in developmental research. As a simple example, the comparison of retention functions under rote versus mediational instructions for each of a number of samples varying in age can provide suggestive information relating to the role of these mechanisms in forgetting. In this context, Kausler (1970) has suggested that the attempted use of mediational devices by subjects who do not use them effectively or use them in inappropriate situations should increase the magnitude of interference (and thus retroactive inhibition) relative to rotely-learned tasks. He suggested that children generally within the age range from six to eight fall into this category, since it is the period characterized by the initial occurrences of spontaneous mediational activity.

Such an hypothesis when carried to its logical extreme implies that spontaneous or induced mediational activity will facilitate both acquisition and simple retention but will increase the magnitude of retroaction and proaction for subjects who cannot inhibit inappropriate mediational activity. The degree to which such an hypothesis is appropriate for the aged remains unexplored. However, it is important to note that the demonstration of facilitative effects of mnemonic prompting on acquisition for the elderly (Hulicka & Grossman, 1967) does not imply that the relationship holds for retroaction functions as well. It is also unlikely that the aged are characterized by a mediational deficiency in the sense implied by Reese (1962) and Kendler and Kendler (1962) when describing pre-five-year-old children.

Response time. The third class of variables which are of interest in this paper have import both for the study of acquisition and retention phenomena, have methodological overtones, and have occupied the interest of a number of investigators concerned with the processes of aging (e.g., Arenberg, 1965, 1967a, 1967b; Canestrari, 1963, 1968; Eisdorfer, 1965, 1968; Eisdorfer, Axelrod, & Wilkie, 1963). In general, the working hypothesis adopted by those concerned with response time is that deficits in acquisition and retention observed in the elderly are attributable, at least in part, to the paced-nature of the tasks. In other words, inferior performance for the aged has been ascribed to the inability to respond in short intervals of time. Eisdorfer, Axelrod, & Wilkie (1963) and Eisdorfer (1965, 1968) and Arenberg (1965, 1967b), Canestrari (1963, 1968) and others have all provided data suggesting that age differences in acquisition are markedly reduced under longer exposure intervals. Furthermore, Arenberg (1967a) has demonstrated that age differences in retroaction observed under task requirements necessitating rapid pacing are absent when the time to respond (i.e., the anticipation interval in paired-associate learning) was increased.

Unfortunately, the largest number of studies concerned with retention or retroaction processes in the aged have used paced procedures in recall. The use of paced-recall tests (in the absence of data collected using unpaced tests) obfuscates the distinction between acquisition and retention processes. In other words, the observation of an age by anticipation interval interaction in retroaction may reflect performance differences which were also measured during acquisition, "real" differences related

to retention and/or retroaction, or both. This is especially true if acquisition and retention measures are collected under the same exposure intervals. Fortunately, exposure intervals used in the acquisition and retention phases can be varied independently of one another or factorially manipulated.

Eisdorfer (1968) and others have also invoked the distinction between learning and performance and have provided suggestive evidence that interactions of age and exposure intervals in acquisition reflect performance differences rather than the actual differences in the degree of learning. This possibility has interesting methodological implications in the study of retention processes. For example, the logical consequence of such an hypothesis is that an aged sample would actually "learn" or overlearn a list exposed under conditions of rapid pacing, relative to a younger sample. Subsequent tests of retention would then be biased in favor of the older sample (if an unpaced retention test is used). At the least, the bias would be expected to obfuscate any age-correlated retention deficit.

The effects of pacing in studies of retroaction also have theoretical implications beyond those discussed previously. As an example, the interference theory of retention implies that retroactive inhibition is a function of two component processes, unlearning and competition-at-recall (e.g., Keppel, 1968). Unlearning refers to an extinction-like process which occurs as a function of interference between competing habits in acquisition. Competition-at-recall refers to the "blocking" from recall of latently available responses by stronger competing habits. The magnitude of retroactive inhibition obtained using paced-recall tests is assumed to

reflect the joint effects of both processes whereas recall using conventional unpaced tests is assumed to reflect only unlearning (Kausler, 1970; Keppel, 1968). It is possible that the aged are more susceptible to competition-at-recall than are younger subjects. This possibility looms even larger in view of the effects of the pacing variable in acquisition. It is important to note, however, that appropriate tests of this hypothesis must guarantee an equal degree of learning for each of the samples employed in the study.

In summary, the developmental research concerned with transfer and retroaction has been predicted on the notion that both the very young and the elderly are "interference prone" (e.g., Jerome, 1959). The present paper has highlighted some of the possible explanatory mechanisms which underly such an hypothesis. Variations of the "interference proneness" hypothesis have been invoked a number of times in other contexts to explain, for example, acquisition and transfer deficits in children younger than five (White, 1963) learning, mediational, and retention deficits in the retarded (e.g., Lipman, 1963), and in schizophrenics (e.g., Lang & Buss, 1965; Mednick, 1958), and in high-anxious subjects (e.g., Spence, 1958; Eysenck, 1963). However, these hypotheses have all been proposed, albeit not directly, in the context of specific transfer mechanisms (e.g., see Goulet, 1968a, 1968b, 1968c). It is perhaps worthwhile to briefly explore this hypothesis from the viewpoint of non-specific transfer mechanisms, the interactive influences of specific and non-specific transfer in determining the magnitude of retroactive and proactive interference, and the ways of experimentally manipulating these components.

As a direct example of the potential influence of non-specific transfer mechanisms on retention, Underwood and Schulz (1960) have suggested the presence of a selector mechanism whereby young adult Ss adopt a response set or disposition to limit themselves to the repertoire of required responses when exposed to learning materials. Subsequent recall of these materials thus may be assumed to be a function either of the degree to which the response set was established or utilized in acquisition, the Ss' success in reestablishing this response set during the period of recall, or both. In the context of research on aging, retention deficits in elderly populations may have their locus in the acquisition process *per se* or during the retrieval or recall phase. And, in the context of life-span changes in retention, the relative effects of these factors may be different for children and the aged; i.e., any retention deficit may be localized primarily in acquisition for young children (through lack of differentiation) and in the retrieval phase for the aged.

Retention, and indeed the magnitude of interference reflected in transfer and retroactive inhibition, has also been shown to be a function of the type of prior practice to which young adult Ss have been exposed. For example, Postman (1964) and Keppel and Postman (1966) have found that the magnitude of negative transfer manifested when Ss are exposed to the A-B, A-C transfer paradigm was decreased when Ss were provided prior practice with this paradigm. Similarly Postman (1969) has demonstrated that retroactive inhibition observed with this paradigm is markedly reduced when practice relevant to this paradigm (except with different lists) is provided. In effect, Postman suggested that Ss acquire certain paradigm-specific skills in learning (in this case, skills to circumvent retroactive

inhibition) which can be generalized to later experimental situations which require these skills. Furthermore, Postman (1969) suggested that since retroactive inhibition is rapidly reduced by relevant experience, retroactive interference of the type described by the A-B, A-C paradigm may play a limited role in forgetting which occurs outside the laboratory. In other words, Ss motivated to retain old habits may readily adopt strategies which lead to the circumvention of retroactive inhibition and thus "permit the steady accumulation of the products of learning" (p. 293).

The implications of results such as these for developmental and/or aging research are clear. For example, young children may not have acquired these higher-order rules or strategies to circumvent the interference manifested in negative transfer and retroactive inhibition, whereas such rules or strategies may be relatively unavailable for the elderly for reasons of lack of recent practice or because of alternate, perhaps competing, strategies which prevent their efficient use. It is also possible that such higher-order non-specific habits are subject to interference in the same manner as that described to specific habits.

Postman and his associates [see Postman (1969) for a review of this research] have unequivocally demonstrated the role of non-specific transfer mechanisms in transfer and retroaction. However, it is also important to mention that the usefulness of these acquired strategies in counteracting interference is not all-encompassing. As an example here, Keppel, Postman, and Zavortink (1968) have demonstrated that massive amounts of practice (i.e., the acquisition of 36 paired-associate lists) designed to provide learning-to-learn experience did lead to more rapid acquisition of lists learned later in the series. However, proactive interference

as measured by recall of each list 48 hours after acquisition, was cumulative and massive in nature. In their experiment approximately 30 percent of the first-learned list was unavailable after 48 hours. However, the magnitude of proactive interference approximated 95% for the thirty-sixth list learned. Such results were attributed to the increasing failure to discriminate between the appropriate responses (i.e., those from the immediately preceding list) and inappropriate responses (i.e., those from earlier-learned lists). Proactive interference stemming from similar sources may account for proactive inhibition which is manifested in non-laboratory or naturalistic settings, such an hypothesis suggesting that PI should be massive in the elderly relative to younger populations.

In conclusion, this paper has emphasized the discussion of variations on the "interference proneness" hypothesis as it relates to the magnitude of retroaction and proaction in the young and the elderly. Previous research related to these problems has exclusively viewed these phenomena within the context of specific transfer mechanisms and with some exceptions, has placed the research emphasis on describing the nature of age-performance functions. The emphasis here has been on experimental manipulations and the identification of non-specific transfer mechanisms as they relate to developmental changes in retroaction and proaction.

The emphasis on nonspecific transfer mechanisms has both methodological and theoretical implications. Methodologically, the provision of learning-to-learn practice, and training or instructions in the use of mnemonic aids in learning may assist in equating for the degree of learning and indeed the type of learning among the samples for which retention is being compared. In other words, alternate, empirical methods are provided to

control for sources of confounding which mitigate against unbiased age-comparisons of the processes of retention and memory. Theoretically, the emphasis on nonspecific transfer mechanisms points to the need for the experimental analysis of higher-order habits whose effects on retention are manifested over the long term, and quite possibly, contribute the most important sources of variance in developmental comparisons.

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Footnote

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